5-2010

Overclaiming and the Medial Prefrontal Cortex : A Transcranial Magnetic Stimulation Study

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OVERCLAIMING AND THE MEDIAL PREFRONTAL CORTEX: A TRANSCRANIAL MAGNETIC STIMULATION STUDY

BY

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A Master's Thesis Submitted to the Faculty of

Montclair State University

In Partial Fulfillment of the Requirements

For the Degree of Master of Arts

May 2010

College/School College of Humanities and Social Sciences

Department Psychology

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May 6, 2010

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Degree Conferred: May 2010

Abstract

The tendency to claim more knowledge than one actually has is common and well documented, however little research has focused on the neural mechanisms that underlie this phenomenon. The goal of the present study was to investigate the cortical correlates of overclaiming. Transcranial Magnetic Stimulation (TMS) was delivered to the Medial Prefrontal Cortex (MPFC), Supplementary Motor Area (SMA), and Precuneus during the presentation of a series of words that participants were told made up a Cultural I.Q. test. However, participants were not informed that 50% of the words were actually fabricated. False claiming was reduced following MPFC TMS. Furthermore, reaction time decreases following MPFC TMS indicated that participants engaged in less reflection during the task, suggesting a potential reduction in social monitoring of behavior.

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2010

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Misperceptions about the self and others pervade social life, and the degree to which individuals can correctly perceive and report on their abilities has been debated (Paulhus, Harms, Bruce, & Lysy, 2003; Paulhus, 1998; Kwan, Barrios, Ganis, Gorman, Lange, Kumar, Shepard, & Keenan, 2007; John & Robins, 1994). In the domain of trait attributions, one may find a large discrepancy between the perception and presentation of self-related information and the actual reality of those characteristics (Alicke, 1985; Kwan, John, Kenny, Bond, Robins, 2004; Neisser, 1988). Motivation to portray oneself in a more positive light is quite common in social interactions. Snyder (1974) describes monitoring of the self as the process through which people regulate their own behavior in order to be perceived in a favorable way. With the use of social comparison information, it is possible to not only direct the appropriateness of one's actions from situation to situation, but also to present the most favorable image of the self to others (Snyder & Cantor, 1980; Snyder & Simpson, 1984; Snyder & Gangestad, 1982; Amodio & Frith, 2006). This egoistic bias represents a deceptive tendency to enhance one's social, moral, physical, and intellectual status (Paulhus & John, 1998). Specifically, this self-enhancement bias can result in an individual reporting higher intelligence or claiming to have more knowledge than one actually possesses (Paulhus & Harms, 2004; Paulhus, Harms, Bruce, & Lysy, 2003).

In studies of desirable responding, Paulhus (1991) has defined overclaiming as the tendency to claim more knowledge than is possible. With the overclaiming phenomenon, it has been demonstrated that false knowledge can be claimed on tests requiring individuals to admit familiarity with non-existent or impossible topics or events (Paulhus et al., 2003). Such common inclinations to overclaim may serve to maintain self-esteem, promote social desirability, and aid in impression management (Mesmer-Magnus, Viswesvaran, Deshpande, & Joseph, 2006). Biases of this nature may be adaptive and reveal a connection to mental health, particularly positive self-regard (Bonnano, Field, Kovacevic, & Kaltman, 2002; Sedikides, Rudich, Gregg, Kusmashiro, & Rusbult, 2004).

One of the most valuable sources of self-information consists of feedback given by others on one's personal characteristics and behaviors. People often pay close attention to how other people view and assess their own personal characteristics. These appraisals from the environment allow a person to learn about the self (Morin, 2004). They can also be used to develop internal standards for self-evaluation. In addition, they can trigger self-observation, especially when the information does not fit one's current self-concept (Morin, 2004). Research suggests that people not only construct their self-image using direct feedback from others, but they are also influenced by how they think others view them (Morin, 2004). This reflected self-awareness often involves a social comparison process of the self to another person. By comparing oneself to an inferior other, an individual can feel superior, successful, and satisfied (Lockwood & Matthews, 2007). However, finding out that another person is more competent or more intelligent than oneself can often be discouraging and may lead to low self-esteem and depression (Lockwood & Matthews, 2007). In order to reduce the damage done by such comparisons, people usually adopt biased processing of self-related information. That is, people have a tendency to readily accept positive information about the self whereas negative or threatening information goes through a more critical evaluation process and is often disregarded (Epley & Whitchurch, 2008). This positive illusion arises in order to compensate for the gap between the way an individual perceives oneself and others (Kwan, John, Kenny, Bond & Robins, 2004). Thus, although social feedbacks is valid, it is not always an accurate source of self-information, and even in the face of truth, people can misinterpret the information and form overly positive self-concepts during the process of introspection (Morin, 2004).

Researchers have yet to fully explain the process of overclaiming. Overclaiming may result, in part, because of a memory bias in which humans tend to find familiarity in almost everything (Williams, Paulhus, & Nathanson, 2002). Other empirical evidence confirms such a trend and suggests an adaptive prevalence of false memories related to the self (Okado & Stark, 2003). False memories represent imagined depictions of reality that are accepted as truth (Gonsalves, Reber, Gitelman, Parrish, Marsel-Mesulam, & Paller, 2004). The extent to which overclaiming is an automatic or conscious process has not been fully investigated (Paulhus & Harms, 2004). Despite the ambiguities, it is generally agreed upon, that at some level, respondents are not willing to admit ignorance on a topic that seems like it should be known (Paulhus, 1991). Specifically, Bradley (1981) highlights that this overconfidence is especially likely to occur in areas of perceived expertise. Overall, most of the research on overclaiming has focused on the degree to which it represents an ego-protecting response. A focal point in the literature has been on individual differences, such as narcissism, that are linked to overclaiming (Paulhus & Williams 2002). There has been comparably less work presenting it in the framework of deceptive self-monitoring and little research examining the neural correlates of overclaiming.

While Paulhus and Reid (1991) described the overclaimer as being prone to self-deceptive positivity, few have labeled the phenomenon as overt deception. Deception in this sense refers to a deliberate misrepresentation of information about the self or others (Trivers, 1991; Stevens, Guise, Christiana, Kumar & Keenan, 2007; Spence et al., 2001; Vrij, 2001). Such misrepresentations have been classified as Machiavellian social manipulations, and have been linked to both narcissism and a tendency to self-enhance on objective tests (Paulhus & Williams, 2002). Byrne (1998) describes this intelligence as a mechanism that has evolved out of the complexity of living in close social groups. As an adaptive ability, deceptive behavior characterizes many of our social interactions (DePaulo, 1998). Such deception allows us to have exaggerated perceptions of control in conditions of extreme adversity (Taylor & Armor, 1994; Bonnano et al., 2002), and enables us to deal with a social environment that is simultaneously competitive and cooperative (Byrne, 1998).

Deception is intimately linked to the ability to attribute mental states to others. If one can understand one's own thoughts through introspection, one can also infer other people's thoughts based on one's own mental state. This process is called perspective taking or theory of mind (Premack & Woodruff, 1978). It has been discovered that there is a positive relationship between theory of mind and deception ability (Johnson et al., 2005). Because intentional deception requires the understanding of the mental state of another, it is necessary for one to possess a theory of mind in order to successfully deceive others (Johnson et al., 2005). For instance, people with schizotypal personality traits who lack self-awareness also demonstrate deception deficits (Barnacz, Johnson, Constantino, & Keenan, 2004). Furthermore, cognitive and emotional deficits may lead to decreases in deception use or ability (Johnson et al., 2005).

Sedikides (1993) categorized the self-evaluation process into three primary routes: self-assessment, self-verification, and self-enhancement. Self-assessment refers to gathering of objective self-relevant information (i.e. taking exams such as an IQ test or GRE); self-verification is a process of trying to reconfirm one's preexisting self-concept by seeking feedback that already exists in one's self-image; self-enhancement involves positive biasing of self-relevant information (Sedikides, 1993). Thus, self-evaluation requires analyzing the self by combining the internal self-image and public self-representation. Many studies have demonstrated that among three major self-evaluation processes, the motivation to self-enhance plays the most powerful role in determining and forming the self-concept (Epley & Whitchurch, 2008; Guenther & Alicke, 2007; Sedikides, 1993).

Little is known about the neural mechanisms underlying self-enhancement bias since there is no direct and accurate way to measure the neurological correlation between the brain and self-evaluation. However, through neuroimaging and patient population studies, it is possible to predict that certain brain regions are involved in the process. Indeed, many studies have indicated a possible role for self-evaluation in the Medial Prefrontal Cortex (MPFC) (Kwan et al., 2007). Neuroimaging studies have presented a number of findings of particular relevance to self-monitoring, self-enhancement, and self-related deception. While different types of deception reveal varied patterns of activation, it appears that the Medial Prefrontal Cortex (MPFC) plays an important role in processing self-related information necessary to misrepresent characteristics of the self. Specifically, the MPFC shows strong activation in self-referential processing (Oschner et al., 2005; Johnson et al., 2005; Izuma, Saito, & Sadato, 2009). For example, reflecting on one's own thoughts, personality traits, or personal reputations involves MPFC regions (Izuma et al., 2009). Oschner et al. (2004) suggested that sub regions of the MPFC are selectively activated for self-judgments, and Macrae et al. (2004) concluded that activity in the MPFC significantly predicted memory performance for self-relevant judgments. In addition, it should be specified that such activation in the cortical midline regions is potentially stronger in reference to the present self, as differentiated from appraisals of the self in the past (D'argenbeau et al., 2008).

When comparing the self to close others on desirable and undesirable traits, a recent study found that TMS delivered to the MPFC disrupted self-enhancement, as compared to stimulation to the Precuneus (Pz) and a sham condition. (Kwan, Barrios, Ganis, Gorman, Lange, Kumar, Shepard, & Keenan, 2007). In this study, participants were presented with egoistic and moralistic words to determine if the positive or negative adjectives described themselves. It was found that TMS disrupted yes responses to egoistic words, suggesting a selective role of the MPFC for self-enhancement (Kwan et al., 2007). For self-evaluations and social desirability, Craik et al. (1999) also found involvement of the MPFC regions in judgments of trait adjectives during Positron Emission Tomography (PET). During self and other judgment trials, significantly greater activation of MPFC was observed during "self" trials than "other" trials using fMRI (Heatherton et al., 2007). Moreover, depressed individuals, who exhibit less or no self-enhancement motivation than non-depressed individuals, showed decreased blood flow to the MPFC in PET studies (Barrios et al., 2008). Taylor & Brown (1988) suggested that mentally healthy individuals have a tendency to have unrealistically positive views of the self, exaggerated perceptions of personal control, and unrealistic optimism. Thus, non-depressed and mentally healthy individuals are likely to indicate more desirable ratings for themselves as compared to their best friend during the baseline condition (Sham TMS). Thus, TMS delivery to MPFC may decrease participants' tendency to self-enhance compared to a Sham TMS condition (Barrios et al., 2008; Kwan et al., 2007). Based on these studies, it is possible to predict that MPFC plays a critical role in self-evaluation, and is particularly important for comparing the self to others.

With regards to deception, Langleben et al. (2005), in an fMRI study, found increased superior medial and inferolateral prefrontal cortical activation during deception. Spence et al. (2001) and Lee et al. (2002) found MPFC, anterior cingulate cortex (ACC) as well as bilateral ventrolateral prefrontal cortical activity during deceptive responses. Additionally, a study by Ganis and colleagues (2003) revealed similar links between deception and changes of MPFC, ACC, motor cortex, and occipital activation. It was concluded by Spence et al. (2005) that MPFC and ACC are indeed involved in deception. Lou et al. (2004) suggested that the medial parietal region could be thought of as a nodal structure in self-representation functionally connected to both the right and the medial prefrontal cortices. Their TMS findings indicated that this network has similarities to networks of the resting conscious state, which may demonstrate that self-monitoring is a main function of resting consciousness (Lou et al. 2004). Similarly, Gusnard et al. (2001) suggested that self-reflective thought, as mediated by the MPFC, may represent a default mode of mental activity, and Johnson et al. (2006) was in accord with this position distinguishing the dorsal MPFC as an area associated with an inward-directed self focused agenda. Specifically, these authors found the dorsal MPFC region associated with self-related intentions (Johnson et al., 2006). Furthermore, a review by Schmitz and Johnson (2007) implicates the dorsal-ventral axis of the MPFC as an ideal substrate for the evaluation and manipulation of self-relevant information necessary for the process of self-monitoring in a social environment. Nevertheless, these studies were not designed to test self-enhancement bias in the form of overclaiming. Thus, the neural correlates of overclaiming remain largely unknown.

If overclaiming is a form of deceptive self-monitoring that relies highly on self-relevant processing, it is plausible that it may be mediated, in part, by contributions of the MPFC. To test this possibility, the current study utilized Transcranial Magnetic Stimulation (TMS) in a "virtual lesion" design. In this manner, TMS allows one to temporarily disrupt processing of brain regions during cognitive tasks. An advantage of this method is that a causal role can be determined in light of the recent neuroimaging findings on deception.

In this study, we delivered TMS to the MPFC under conditions that would reveal overclaiming behavior on a basic response task. To measure overclaiming, a technique similar to that used by Paulhus and Bruce (1990) was implemented in which respondents had to rate their familiarity with a set of items presented as a Cultural I.Q. test. The list contained a corpus of items that an educated individual would likely know, including notable historical individuals, novels, events, vocabulary, and characters (Paulhus & Bruce, 1990). Unbeknownst to the participants, 50% of the items on the I.Q. test were foil words, fabricated to sound like real items. A yes response would indicate familiarity with the term, and a no response would indicate having never heard of the term. Based on previous research, we expected that participants would behaviorally respond in ways that indicated overclaiming, that is, participants would say that they knew a number of the foil words, even though there is no possibility that they definitively had knowledge of that term. Importantly, we predicted that TMS to the MPFC would affect overclaiming, such that disruption of the region would reduce the overclaiming bias.

To control for the possibility that TMS merely disrupted one's ability to process self-relevant information, and not specifically overclaiming, TMS was also applied to the Precuneus (Pz). This region has been shown to be more engaged when processing self-related information across a number of self-evaluation experiments (Segar, Stone, & Keenan, 2004; Lou et al. 2004). To our knowledge no studies have implicated Pz in deception. Hence, stimulation to Pz would possibly slow down reaction times, but not influence overclaiming significantly. TMS was also delivered to the supplementary motor area (SMA) as a control stimulation site because it has not been implicated in self/other differentiation or deception. Sham TMS, or application of the magnetic coil to the scalp without stimulation served as our absolute control condition.

Method

Participants

Eleven university students were recruited (8 males and 3 females; age M=27.1 SD=10) via flyer and word of mouth for the study. All participants were paid 25 dollars for their participation and were treated in accordance by guidelines set forth by the Internal Review Board at Montclair State University and guidelines of the American

Psychological Association. All TMS was delivered within the parameters provided by Wasserman (1998).

Materials

A Magstim, single-pulse TMS device was used for all stimulation. A 70-mm figure-of-eight coil was used throughout the experiment. All stimuli were presented on a Dell desktop computer with a 17" CRT monitor. All triggering occurred through BioPack amplifiers, which were also used for motor threshold determination.

Stimuli

All items were drawn from the comprehensive list adopted by Paulhus et al. (2003) containing words adopted from Hirsch (1988). The items contained words referring to historical names, events, books, fine arts, poems, literature, authors, social science, physical science, law, and popular culture (Paulhus et al. 2003). The foil words were created to appear as if they legitimately belonged to one of these categories of cultural literacy. Foils did not resemble any of the other target words in the study, nor did they closely resemble other already existing terms. As in Paulhus et al. (2003) they were created to appear to be plausible members of the same categories (Paulhus et al. 2003). Participants were informed that they were taking a Cultural I.Q. test, and were instructed to respond (yes or no) on the keyboard, depending upon whether they knew the word that appeared on the screen. They were not informed that 50% of the terms being presented consisted of foil words.

TMS Procedure

Wasserman's (1998) guidelines were used to set the limits of stimulation throughout the testing sessions. The testing was executed in two phases: motor threshold determination and the experiment proper. Participants were initially fitted with a tight Lycra swim cap. Suprathreshold TMS pulses were delivered to locate the region that provided the greatest MEP response to the contralateral Abductor Pollicis Brevis (APB) muscle. The coil was relocated across the scalp until the most responsive region was found that induced MEPs of maximal peak-to-peak amplitude. Determination of individual MT was employed using procedures outlined by IFCN (Rossini et al., 1994), such that threshold was established when 50% (5 of 10) of the TMS pulses delivered induced a measured MEP of >50 μV. All active stimulation was delivered at 90% MT during the experiment. All MT measurements were made via BioPack MP150 amplifiers and software. Once the MT intensity was determined, the cap was marked in the 10/20 International System for EEG electrode positions.

The regions of interest were the Precuneus (Pz), the MPFC, and the SMA. Cortical placement was identical to those used in similar studies (Barrios, Kwan, Ganis, Gorman, Romanowski, & Keenan, 2008; Kwan et al., 2007). First, one third of the distance, nasion to inion, was measured for each participant. MPFC was 1.5 cm anterior to this location, and SMA was identified as being 3 cm posterior to this location. The coil was oriented parallel to the mid-sagittal line for all stimulation with the handle pointed in a posterior orientation (except for APB MT determination in which the coil was held at ~45° from the hemispheric line). The depth of cortical stimulation was never greater than 2cm, ensuring that the initial effects of TMS were concentrated to the areas of interest (Wasserman, 1998).

Baseline performance was measured by a Sham condition. During sham, the TMS coil was held at 90° orientation and held over Cz (standard 10/20 system coordinates). Because the regions (MPFC and SMA) are somewhat adjacent, single-pulse TMS was employed to avoid cortical spread. The coil was held manually (e.g., Lou et al. 2004) to ensure quick shifting of blocks as they changed approximately once per minute. For all testing sessions, participants wore protective earplugs to prevent transient threshold shifts caused by the acoustic artifact generated by the discharge of the TMS coil (Wassermann, 1998).

Measures of Overclaiming

The list of words was divided into 4 blocks containing 36 words per block. For each block 50% of the words were real terms (e.g., Ayn Rand, Ampersand), and 50% were fake terms (e.g., Murphy's Last Ride, Trey Surf Wear). Therefore, TMS to each of the four brain regions was delivered during 36 word presentations. All words were randomized, and all lists were counterbalanced across participants. The order of all brain region sites was randomized. All words within a block were also randomly presented.

Participants indicated their response (yes or no) via a standard keyboard. For all trials, TMS was delivered 500ms after the word appeared on the screen (See Figure 1). Response times (RT) were measured as the amount of time after the TMS pulse.

Results

We first analyzed reaction time. Overall reaction time was 574.67 (SE = 72.80). Response times for all conditions are reported in Table 1. To determine if TMS influenced reaction time, we performed a 2 (veracity) x 4 (brain site) repeated measures ANOVA. The DV was reaction time (RT). There was no overall interaction between the IVs ($F(3, 30) = 1.34$ $p = .28$). We then examined the main effects. It was found that there was a significant difference in reaction time for word veracity ($F(1, 10) = 22.37, p < .001$). Real words ($M = 535.98$, $SE = 70.59$) were identified significantly quicker than fake words ($M = 613.37$, $SE = 75.84$). Additionally, there was a trend for the main effect of brain area ($F(3, 30) = 2.35, p = .09$).

Because the main effect of brain region existed as a trend only, we employed a series of comparisons to sham. Only MPFC differed significantly from sham ($t(10) = -2.68, p = .023$). This result indicated reaction time during MPFC stimulation ($M = 499.17$, $SE = 70.65$) was significantly less than reaction time during sham stimulation ($M = 617.93$, $SE = 89.85$). Multiple comparisons were controlled for by employing a modified stepwise Bonferroni test.

We were unable to include all of the responses in the overall ANOVA due to a significant number of blank cells for one participant (for example Participant 3 never answered 'yes' to a fake word during sham stimulation). Because of these blank cells, we considered response independently. First, there was no significant difference between yes (yes response indicated that the person thought they knew the word) and no responses ($t(10) = 1.58, p = .15$). There was a significant interaction between word veracity and response ($F(1, 10) = 5.43, p = .04$). Post-hoc tests revealed the only difference occurred between yes responses for real and fake words ($t(10 = 3.26, p = .009$). The nature of the effect indicated that yes responses for real words ($M = 478.94$, $SE = 51.18$) were significantly quicker than yes responses for fake words ($M = 617.04$, $SE = 68.12$).

We then analyzed responses of identification (yes responses). The overall identification of words was .46 ($SE = .055$). To simplify presentation, all data are given in terms of proportion of positive responses. We first performed a 4 x 2 ANOVA for brain region by veracity to identify where differences in identifications came from. Specifically, we were interested in the main effects. For veracity, it was found that there was a significant main effect such that real words were identified at a significantly higher rate than fake words ($F(1, 10) = 17.14$, $p = .002$). The real word identification rate was .58 ($SE = .059$). The fake word identification rate was .34 ($SE = .065$). There was no main effect for brain region, indicating overall response rate did not change due to TMS ($F(3, 30) = .06$, $p = .98$). The main hypothesis in terms of responses was that the overclaiming bias would decrease across brain regions compared to sham. During sham TMS, the rate of claiming to know fake words was .34 ($SE = .072$). To further analyze the interaction we examined fake words by employing a Chi Squared Test in which we subtracted each participant's number of fake yes responses from their real yes responses. For example if a participant claimed knowledge of 11 real words and 4 fake words, his/her index would be 7. This number represents the difference between real and fake claims of knowledge. For the sham condition, the average difference was 2.82. All four conditions were compared in terms of this response value. It was found that there was a significant overall difference between the conditions ($X^2(3) = 14.32$, $p = .002$) (See figure 2).

To test the nature of this difference, each active brain group was compared to sham. It was found for MPFC the mean difference was 5.45, which was a significant difference when compared to sham ($M = 2.82$) ($X^2(1) = 9.24$, $p = .002$). This difference indicated fewer knowledge claims for fake words with MPFC TMS than for sham. Neither Pz ($M = 4.0$) nor SMA ($M = 2.73$) differed significantly from sham. These data indicate that overclaiming responses were reduced only by MPFC stimulation.

Inspection of individual data revealed that none of the subjects undergoing MPFC TMS endorsed fake words more often than real words, whereas 18.2 % (n = 2) claimed to know fake words more often than real words in the sham condition. This proportion, 18.2 percent, was the same for Pz. Surprisingly, 36.4% (n = 4) of participants undergoing TMS to SMA claimed to know fake words more often than real words.

Discussion

The data suggest that overclaiming is significantly reduced when TMS is delivered to the MPFC. The difference between claiming to know real and fake words varied depending on TMS delivery site, such that false claiming (e.g., overclaiming) may be mediated via the MPFC. Furthermore, decreases in the reaction time found following MPFC TMS indicated that participants engaged in less reflection during this task, suggesting a potential reduction in social monitoring of one's behavior.

Previous research has described the overclaiming phenomenon as a deceptive bias involving self-related information, namely one's knowledge about particular topics or events (Paulhus et al., 1991; Paulhus & Harms; 2004). Neuroimaging findings have demonstrated that the MPFC plays an important role in self-referential processing and reflecting on self-relevant information (Oschner et al., 2005; Johnson et al., 2005). Regions of the MPFC have also been demonstrated to be important for the appraisal of positive traits for the self in studies employing TMS (Barrios et al., 2008; Kwan et al., 2007) and PET (Craik et al., 1999). Furthermore, the ability to deceive about self-information shows strong activation in the MPFC in studies utilizing fMRI (e.g., Ganis et al., 2003; Langleben et al., 2005; Spence et al., 2006). This investigation provides further support for the role of the MPFC region in deceptively presenting misinformation about the self, specifically, how much one knows about popular culture.

The misperception and misrepresentation of vital personal attributes such as social, moral, physical, and intellectual traits is well documented in research on social monitoring and self-enhancement (Brown, 1986; John & Robins, 1994; Snyder, 1974; Snyder et al., 1980). The inclination to give desirable responses is guided by the motivation to present the best impression of oneself from one social situation to another (Mesmer-Magnus et al., 2006; Snyder, 1974). With regards to social appropriateness and social comparisons, the tendency to monitor one's actions is quite common. In situations that induce either public or private self-awareness, differential response patterns have been observed between high and low self-monitors (Web, Marsh, Shneiderman, & David, 1989). This implied connection between self-awareness and social monitoring is supported by neuroimaging findings presented by Lou and colleagues (2004) describing a network of structures involved in self-representation that are functionally connected to the right and medial prefrontal cortices. Our study contributes additional findings that networks involving the MPFC are important for the processes underlying positive self-presentation and social monitoring. Specifically, our findings further demonstrate that the MPFC may be important for monitoring of the self in a socially demanding situation.

A number of studies on desirable responding and overclaiming have focused on personality factors (Paulhus & Williams, 2002; Taylor & Lerner, 2003; Paulhus & John, 1998; Taylor et al., 2003). For example, narcissism was found by Paulhus (2002) and Kwan et al. (2008) to be linked to overclaiming and self-enhancement respectively. Individual differences have also been observed in the domain of social monitoring. In validation studies of social monitoring scales, Snyder (1973) found that theater actors scored highest on scales of self-monitoring, while hospitalized psychiatric patients scored lower than university students. It would be interesting for future studies to investigate activity in the same brain regions with respect to such individual differences and personality variables. Furthermore, it would be beneficial to examine the extent to which those individuals who demonstrate overclaiming also score high on measures of self-enhancement.

The virtual lesion design employed by this investigation has enabled us to establish a link between the brain area of the MPFC and the behavior in question. More research is needed to determine a definitive causal relationship between the MPFC and deceptive self-monitoring as witnessed by the overclaiming technique. It remains to be specified whether this relationship is directly representing a specific connection to false knowledge claims or more generally to impression management, social monitoring, or self-related deception. While it may be premature to propose a definitive theoretical link between deception and overclaiming, it is important to understand whether overclaiming is as deliberate and purposeful as overt deception, or whether it exists merely as a failure of signal detection. It may very well be the case that overclaiming on psychometric tests qualifies as a more automatic phenomenon, whereas overclaiming in the context of a social interaction is more willful and conscious. This key difference needs to be examined in future work. Moreover, comparisons between true identification and false knowledge claims cannot be drawn with this paradigm. True identification was not of interest in this study, but it would certainly be beneficial for future investigators to pinpoint whether participants actually knew the real words that they claimed to know, possibly by testing knowledge after TMS procedures. Furthermore, conclusions drawn from this experiment are limited by a somewhat small sample size, and an unequal number of male and female participants.

Previous studies have pointed out that the MPFC may mediate "feelings-of knowing" and stimuli familiarity (Schnyer, et al., 2005; Macpherson et al., 2008). It may be possible that TMS to the MPFC might disrupt the signals associated with the tendency for fake items to seem familiar. Future studies should seek to investigate the extent to which an overclaiming bias might actually represent a false memory bias in which humans find familiarity in almost everything (Williams, 2002; Okado & Stark, 2003). Additionally, it is possible that a lesion to the MPFC might lead to a decreased ability to accurately assess one's memory for a given topic or event (Schyer, et al., 2005).

Consideration for possible widespread changes in areas functionally connected to the MPFC due to TMS also warrants discussion. For example, Hayward & colleagues (2007) reported that stimulation to the MPFC led to additional changes in the anterior cingulate cortex (ACC), as well as other temporal and parietal regions. The MPFC has been described as being part of greater neural networks involved in social cognition, therefore it is important to realize that a "virtual lesion", although initially restricted to the MPFC, could lead to changes in other areas. While TMS to cortical regions only has effects at depths no greater than 2cm, it certainly influences other regions later on in the temporal sequence (Rossini, et al., 1994).

When studying deceptive social behavior it is always a challenge to do so in naturalistic ways (Sip, Roepstorff, McGreggor, & Frith 2007). Eliciting realistic behaviors in the laboratory can be difficult without sufficient motivation from participants. It is important when studying deception to take into account the intentions of the participants as well as the context (Sip et al., 2007). Therefore, it is to the advantage of researchers to study deceptive behaviors that are already intrinsically motivated within the typical human repertoire, such as the natural proclivity to self-enhance. Despite capitalizing on this inherent human tendency, our methods still do not completely replicate a naturalistic social circumstance. It cannot be assumed that metacognitive performance on a laboratory "I.Q. Test" reflects behavior that would occur in real life. Therefore, we advise researchers to take this limitation into consideration as more ecologically valid ways to measure overclaiming are developed. The goal of our study was to investigate the cortical correlates of the deceptive tendency to give desirable responses, as witnessed by the overclaiming technique. Overall, participants claimed to know less fake words with MPFC TMS than sham. The results extend the findings implicating this region in deceptive responding and lends significant support to previous studies that link the MPFC to self-referential processing and self-related deception

Figure 1

Experimental Design

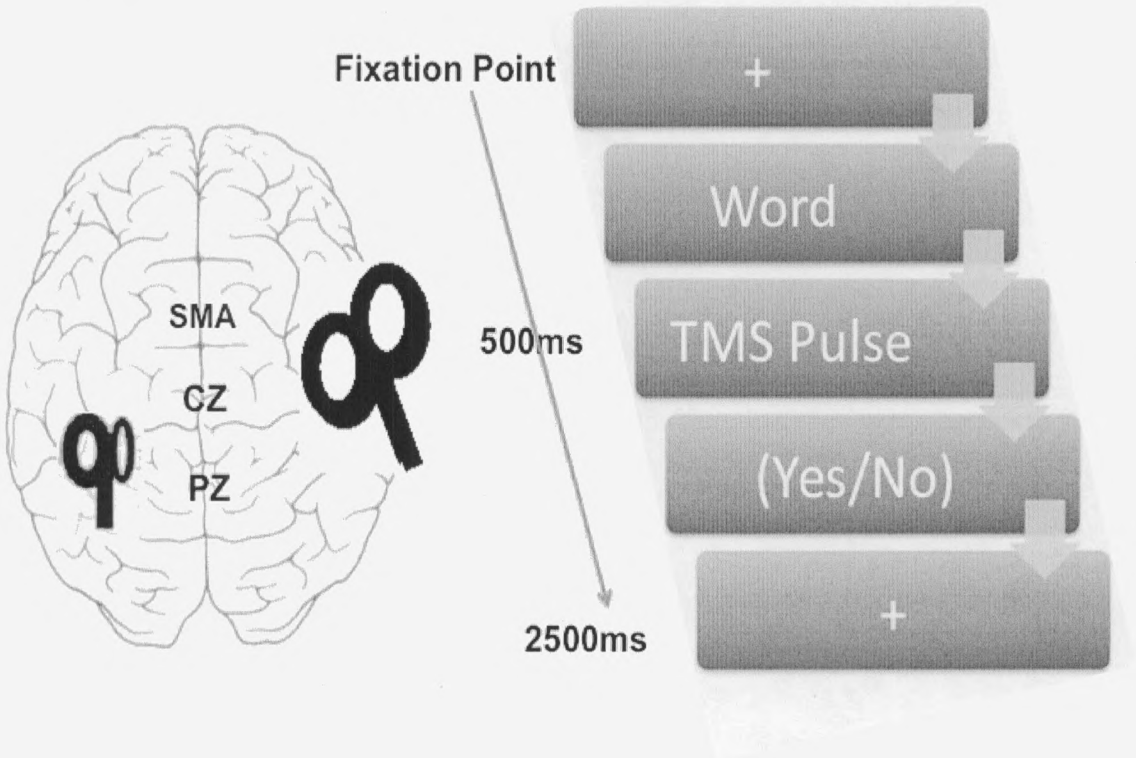

Figure 2

Yes Responses (Real-Fake)

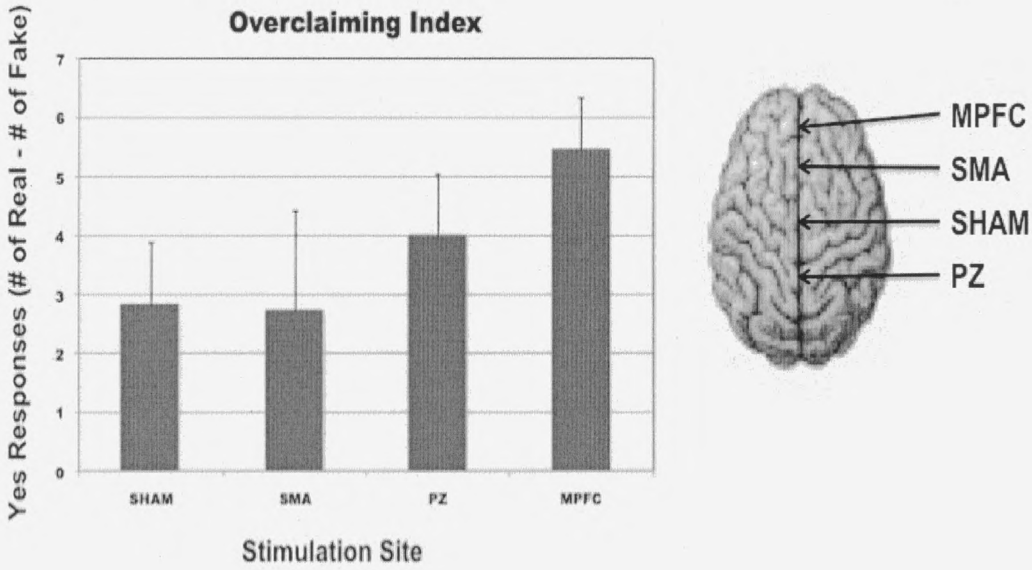

Table 1

Reaction time for fake and real words during each stimulation condition in milliseconds.

Brain Region	Fake Words mean (ms)	SE	Real Words mean (ms)	SE
Sham	685.50	106.27	550.42	76.03
SMA	558.56	70.12	499.53	60.24
Pz	687.86	114.63	617.12	94.98
MPFC	521.57	64.61	476.84	78.38

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